DOCUMENT RESUME

ED 418 859 SE 061 334

AUTHOR	Lin, Huann-shyang
TITLE	Promoting Pre-service Science Teachers' Understanding about the Nature of Science through History.
SPONS AGENCY	Taiwan National Science Council, Taipei.
PUB DATE	1998-04-00
NOTE	19p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (71st, San Diego, CA, April 19-22, 1998).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Chemistry; College Curriculum; *Educational Strategies; Elementary Secondary Education; *Epistemology; Foreign Countries; Higher Education; *Preservice Teacher Education; *Science History; Scientific Methodology; *Teacher Education Curriculum
IDENTIFIERS	Taiwan

ABSTRACT

Identifying the benefit of teaching chemistry through history was the goal of this study that used a quasi-experimental design based on the method of action research. Two groups of students in the last 2 years of a teacher preparation program participated in the study with one group receiving instruction on how to develop and teach chemistry through the history of science and the control group using standard practices. A comparison was made between the two groups regarding their understanding of the nature of science. The results of the analysis of covariance reveal that the experimental group outperformed the control group. Additional data analysis strategies indicate that the experimental group had a better understanding of creativity, the theory-based nature of scientific observations, and the function of theories. Contains 23 references. (DDR)

Promoting Pre-service Science Teachers' Understanding about the Nature of Science Through History

Huann-shyang Lin

National Kaohsiung Normal University

Address: Department of Chemistry
National Kaohsiung Normal University
116 Hoping 1st Road, Kaohsiung
Taiwan 802

Fax: (07) 711-4633

E-Mail: T1666@NKNUCC.NKNU.EDU.TW

Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Diego, California, April 19-22, 1998. The research presented was supported by the National Science Council, Taiwan, R.O.C.

Promoting Pre-service Science Teachers' Understanding about the Nature of Science Through History

Huann-shyang Lin, National Kaohsiung Normal University

The purpose of this study was to identify the benefit of teaching chemistry through history, using a quasi-experimental design, which was based on the method of action research. A class of senior students was used as the experimental group. The students were receiving the last year of training in a teacher preparation program. After receiving training on how to develop and teach chemistry through the history of science, their understanding about the nature of science was compared with the control group, which was selected from a class of junior students in the same department. The results of the analysis of covariance revealed that the experimental group outperformed the control group. Additional frequency analysis and qualitative data collected from interviews indicated that the experimental group students have a better understanding of the nature of creativity, the theory-based nature of scientific observations, and the function of theories. In the pre-treatment interview, the student explanations concerning the nature of science were based primarily on their intuition. However, in the post-treatment interview, they were able to explain their beliefs by using previous scientists' arguments or hypotheses as examples. This result reveals that the pre-service teachers' understanding about the nature of science was explicitly changed by an understanding of the history of science.

Promoting Pre-service Science Teachers' Understanding about the Nature of Science Through History

There is a growing consensus within the science education community that understanding about the nature of science is a critical objective of science teaching. The knowledge of knowing how science works is requisite for scientific literacy (American Association for the Advancement of Science, 1989). Unfortunately, research studies have found that students do not possess adequate conceptions of the nature of science. For example, Aikenhead and Ryan (1991), Ryan and Aikenhead (1992) used the Views on Science-Technology-Society (VOSTS) instrument to assess high school students' viewpoints on the epistemology of science. They found that the majority of the students hold naive views contrary to the contemporary epistemology of science; Using the "Test on Understanding Science" (TOUS), Mackay (1971) concluded that secondary students lacked sufficient knowledge of the relationship between experiments, hypotheses, models, and theories; With a Likert-scale instrument "Nature of Scientific Knowledge Scale" (NSKS), Rubba, Horner, and Smith (1981) indicated that even high-ability secondary students were not knowledgeable with respect to the nature of scientific knowledge. Although the above studies used different assessment instruments, they revealed that there is a consistent finding that students do not possess adequate conceptions of the nature of science.

In addition to the assessment of students' understanding about the nature of science, several researchers turned their attention to teachers. After conducting a questionnaire to 1000 science teachers, Behnke (1961) found that over 50% of the science teachers felt that scientific findings were not tentative; By comparing the TOUS scores between 51 biology teachers and 87 high ability high school students, Miller (1963) showed that 68% of the high ability students scored higher than 25% of the teachers; Using the Wisconsin Inventory of Science Process (WISP), Carey and Stauss concluded that not only prospective science teachers (1968) but also experienced science teachers (1970) in their studies did not possess adequate conceptions of the nature of science.

The evidence showing the inadequate views of students and teachers with regard to the nature of science has caught attention from science educators, especially the research findings on teachers. Continuing efforts have been taken to study the relationship between teachers' beliefs about the nature of science and their teaching practices (Brickhouse, 1990; Gallagher, 1991; Lederman & Zeidler, 1987). Significant relationships have been found by Brickhouse and Gallagher. Meanwhile, efforts have also been taken to identify the factors which may affect teachers' understanding of the nature of science. It was found that academic variables (e.g., college grade point average, college science courses, or science grade point average) could not be used to improve science teachers' conception of science (Carey & Stauss, 1970). In addition, teaching experience does not contribute to a teacher's understanding of the nature of science (Billeh & Hasan, 1975; Carey & Stauss, 1970). On the other hand, however, Lavah (1969) found that using historical aspects of science teaching in an inservice program, science teachers made significant gains in their understanding of the nature of science. More recently, leaders in the field of the history and philosophy of science argued that the history of science should play a role in science teaching (Brush, 1974; Duschl, 1985; Matthews, 1994; Solomon, Duveen, & McCarthy, 1992). Matthews indicated that one of the potential benefits of teaching the history of science is that it can promote a learner's better understanding of the nature of science.

Although there are potential benefits for teaching history of science, most science teacher preparation programs are not likely to provide such a course simply because of the limitations of time available or the shortage of faculty members who are interested in this field. For this reason, a feasible way would be using some time from existing courses. In this study, the researcher used the chemistry teaching methods course to introduce history of science to prospective chemistry teachers. The main purpose of this study was focused on the investigation of the prospective teachers' improvement in their understanding of the nature of science.

Methodology

Subject

A total of 63 prospective chemistry teachers participated in this study. They were in a 4-year teacher preparation program in a university. Thirty three senior students were assigned as the experimental group, while thirty junior students served as the control group.

Instrument

A modified version of VOSTS (Aikenhead & Ryan, 1992) was used to assess the students' conception of the nature of science. The 11 questions included in this instrument were multiple choice items. Seven items were from the VOSTS and four items were derived from a questionnaire used by Soloman, Duveen, Scot, and McCarthy (1992). The major topics of the questions were: the purpose of scientific models and experiments conducted by scientists; how a theory is produced; the relationship between hypothesis, experiment, and observation; and the tentativeness and durability of scientific knowledge.

Procedure

At the beginning of the school year, both the control and experimental group students were asked to respond to the 11-question instrument. Following the pretest, the experimental group students were presented with a sample of historical-rich teaching material edited by the author. The material described how scientists developed their understanding about atoms, molecules, and atomic weight tables. In order to be consistent with the "historical instructional" characteristics instead of "historical descriptive" described by De Berg (1989), the sample material was equipped with student discussions and hands-on experiments (Lin, In press). The author explained the content and the format of the historical material. The students were asked to read a case study of the history of science to develop similar material for their use in future teaching as the semester assignment. Topics selected by the students ranged from Torrecellie's and Pascal's experiments regarding atmospheric pressure which discarded the Aristotelian doctrine of "Nature abhors vacuum", to Boyle's vacuum pump invention and experiments to confirm the compressibility of air, and the overthrow of the phlogiston theory. Upon completion of the assignment, students shared their historical materials in the teaching methods class. On the other hand, the control group students did not take any courses related to the history of science. Finally, both the control and the experimental group students responded to the instrument again at the end of the semester. In order to better understand what reasons were behind the students' beliefs, six ~~five~~ students were randomly selected from the experimental group for follow-up interviews. Each of them was interviewed for 30-45 minutes immediately after the pre- and post-tests.

Data Analysis and Scoring scheme

The students' answers for each question were classified into either contemporary or traditional as Aikenhead recommended (1991). The changes in their views on the nature of science were analyzed. The frequency and percentage analyses of students' view from pretest to posttest was conducted to reflect the change. In addition, in order to better examine if the experimental group improved more than the control group, the analysis of covariance (ANCOVA) was used. If a student's position was contemporary, a score of 1 for that question was given. Otherwise, a score of 0 was assigned. The total score of the pretest served as covariate, and the total score of the posttest was examined as the dependent variable to compare if there was any significant difference between the two groups.

Quantitative Results

Table 1 presents the percentages of students who changed their views about the nature of science for the 11 questions from traditional to contemporary. It can be seen that except for question # 7, the experimental group had more students change their views than the control group, especially for questions #3, 4, and 8.

Question #3 asked students whether scientists "invent" theories as artists invent sculptures or scientists "discover" theories as miners discover gold. In the posttest, 24.24% of students in the experimental group switched from the view of "discover" to the view of "invent". Meanwhile, only 10% of students in the control group had the same change.

Question #4 asked students how scientists conduct observations while they believed in various theories. The view of believing that scientists would conduct different observations based on their own theories was classified as "contemporary". Table 1 shows that 30.30% of the experimental group students switched from the traditional view to the contemporary view. However, only 20.00% of the control group students had the same change.

Question #8 was about the function of scientific theories. The answer that they are used as tools for explaining what happened in the universe is looked on as "contemporary". Again, there were more students in the experimental group (42.42%) than students in the control group (20.20%) switched from a "traditional" to "contemporary" view.

The result of the analysis of covariance revealed that the treatment made a significant difference in the experimental group students on their understanding of the nature of science. Table 2 shows the mean scores and standard deviations of the two group students' pre and posttests. Table 3 presents the source of variance results. It can be seen that the mean scores of the control group dropped from 4.67 in the pretest to 4.57 in posttest, while the experimental group went up from 4.51 in the pretest to 5.67 in the the posttest. There is a significant difference in the adjusted mean score between the two groups ($p < 0.05$).

Qualitative Results

The comparisons of pre-treatment interview and post-treatment interview results show how and why students changed their views about the nature of science. Since the quantitative results revealed that the experimental group made significant progress in understanding the nature of creativity, the theory-based nature of scientific observations, and the function of theories, the explanations of the following qualitative results will focus mainly on these three fields.

1. the nature of creativity

"Do scientists discover theories like gold miners discover gold or invent theories like artists invent sculpture?" This question was used to ask student A in the pre-treatment interview, she replied with a traditional view saying that "scientific theories are out there in nature, scientists simply discover them." When she was requested to give examples for further explanation of her position, she turned her head down and fell into deep thinking for a while. Finally, she answered "It's very difficult to find an example". In the post-treatment interview, student A confidently indicated that scientists invent theories to explain natural phenomena. Scientists with different beliefs may create different theories for a same phenomenon. The following transcriptions describe the detail (I: interviewer, A: student A).

I: Why did you change your view from "discover" to "invent"? Can you explain it using examples of how scientists invent theories?

A: Yeah, like the ring structure of benzene. So scientists should have the ability of imagination and creativity to be able to invent a theory. I feel the invention of a theory is similar to the creation of a sculpture.

I: Do you think it is possible that scientists with different ideas may invent different theories for the same natural phenomenon?

A: Yeah.

I: Why is it possible? I just want some of your ideas or examples.

A: Well, for example, in the seventeenth century, somebody 【Linus】 hypothesized that the space above the mercury column in a Torricellian tube contained an invisible membrane, which keep the mercury column from falling down. However, Boyle had a different idea, he argued that the main reason was the pressure of the outside air.

For student B, his position was uncertain in the pre-treatment interview. He believed that some theories were invented, but some were discovered by the good luck of scientists. In addition, his explanations were based on well-known fictions instead of the history of science.

I: Can you explain by examples, which theory was discovered with good luck?

B: The discovery of gravity by Newton is a good one. He was sitting under an apple tree and hit by a falling apple. If he was not hit, how can he come up with the idea? His discovery was based on luck.

In the post-treatment interview, student B believed that theories were invented by scientists to explain natural phenomena. He was able to use a historical event to support his position.

I: Are you sure that scientists invent theories to explain natural phenomena?

B: Yeah.

I: Why do you think so?

B: Like the things that happened to Torricelli. After he saw the fact that a water pump could not draw water from a well deeper than 30 feet, Torricelli created the hypothesis of "sea of air surrounding the earth". He proved the existence of atmospheric pressure by providing the mercury tube experiment.

2. The theory-bound nature of scientific observations

The following two student's explanations of the relationship between a theory and a scientific observation provide evidence of their change of understanding about the nature of science. In the pre-treatment interview, both of them simply based their explanation on the intuitions of their experiences. However, in the post-treatment interview, their views had changed and their explanations were based on scientific experiments conducted by previous scientists.

In the pre-treatment interview, student C believed that even though scientists believed in different theories, they may still conduct the same experiment. However, in the post-treatment interview, student C believed that scientists with different theories, would conduct different experiments.

Pre-treatment interview

I: DO you mean that two scientists holding different theories could conduct the same experiment? Why do you think so?

C: Yes. I feel that 【in a same experiment】 individual difference may result in a variety of observational results. Different theories are derived from these results.

I: Can you explain more about your idea with experiments?

C: It's like all students in the same classroom did the same experiment. Finally, every student got different results. ......Therefore, the more correct your experimental procedure, the better your results would be.

I: Would the students create different theories?

C: Since all the experiments we conducted were based on the same theories, we won't [get different theories]. If the observations of our experiments were not based on the same theory, it would be possible.

Post-treatment interview

I: You believed that scientists holding different theories might conduct the same experiment last year. Why do you believe that they will conduct different experiments now?

C: Well, it's possible. When they believed in different theories, their experimental observations would be different. They may seek evidence from different experiments in order to support their own theory.

I: What reason makes you think so?

C: .... In the early days, some scientists believed in the theory of phlogiston, but some didn't. They provided evidence of their beliefs from different experiments. The reason why they conducted different observations was simply because the two groups of scientists believed in different theories.

The following interview result of student D provides more evidence of students' progress in understanding the nature of science. Furthermore, this student clearly figured out that her change had been the result of reading the history of science.

pre-treatment interview

I: If two scientists believed in different theories and they are trying to use their experimental observations to support their own theory, do you think they will conduct the same experiment?

D: Yes, it is possible. Sometimes they will, but sometimes they won't. When they are conducting the same experiment, they may observe different aspects of the experiment, which in turn make different interpretations.

I: Can you explain this using an example?

D: By example? I am not sure of my position.

Post-treatment interview

I: ....why did you choose different answers in the pre and post tests?

D: It may be the result of reading the history of science.

I: What topics of the history of science?

D: Like the topic of the Galvanic Cell or the history of heat.

I: Can you explain more about these topics?

D: [In the eighteenth century], those who believed in the Caloric theory, they accepted that heat was one kind of substance. On the other hand, for those who doubted the Caloric theory (like Count Rumford), they suspected that heat might be a form of motion. Therefore, the two groups of people conducted different experiments in order to support or attack the Caloric theory.

3. The function of theories

In the pre-test, More than half of the pre-service teachers in the experimental group perceived that theories are facts that have been repeatedly confirmed by scientists. However, in the post-test, many of the pre-service teachers changed their beliefs to that theories are tools for explaining natural phenomena. The following transcription can be served to reveal how their opinions changed.

Pre-treatment interview

I: Why do you think that theories are facts that have been confirmed by scientists?

E: As I know, all of the theories were derived from careful, objective, and precise experiments conducted by a group of scientists. If you follow the same procedure as they did, you'll get the same result. So it can be regarded as a fact.

I: Why do scientists conduct experiments?

E: I don't know. All the theories I know are from textbooks. They simply appear as products of scientists' experiments.

Post-treatment interview

I: Why did you change your view to that theories are created to explain natural phenomena rather than facts.

E: After reading the history of heat and temperature, I understand how a theory was developed and accepted by scientists. It's not just like the way textbooks presented as an undoubted product. It's more like something to be used to explain things around us.

Discussion

The potential benefits of teaching the history of science have been indicated by leaders in this field. This study provides empirical evidence of its benefit to understanding the nature of science for prospective chemistry teachers. Among the 11 questions regarding the nature of science, the experimental group made better progress on the following three questions: 1. Do scientists invent or discover theories? 2. How did scientists conduct observations when they believed in various theories? 3. What is the major function of scientific theories?

Using multiple choice items in the investigation of a student's understanding about the nature of science may have limitations in some aspects. For instance, one item of the questionnaire asked students "What expectations are in scientists' minds when they conduct an experiment?", of the four possible answers: 1. They already know (at least they expect) what would happen; 2. They don't know the outcome of an experiment. They just try and see what happens; 3. If they are trying a new experiment, they know nothing and expect all the posibilities at the beginning stage of a new experiment. However, they may have learned more knowledge as they progress in an experiment; 4. Sometimes they know and expect what would happen, but sometimes they don't, answer #1 was classified as a contemporary view, while the choice of #2, #3, and #4 were ranked as traditional views. Although the quantitative analysis showed that only 6.06% of the experimental group switched from traditional to contemporary view, the interview of the six students revealed that all of them have changed their view to some extent. They choose answer #4 in both of the pre- and post-tests. However, in the interviews, when they were asked to estimate the percentage of possibility that scientists know and expect the outcome before conducting an experiment, their estimations increased from 40~50% in the pre-treatment interviews to 80~90% in the post-treatment interviews. It can be explained that pre-service teachers possessed a cartoon like view of scientific experiments (Soloman, Duveen, Scot & McCarthy, 1992) before the treatment, and afterward began to believe that experiments are theory-based. In addition, the students were able to explain why scientists know experimental outcomes using cases in the history of science. Such explanations were not seen in the pre-treatment interviews. Clearly, the multiple choice format of the items in this study are not capable of entirely distinguishing such changes in the students' beliefs. Therefore, it is suspected that the quantitative assessment results of this study are more conservative than the actual degree of change in the students understanding of the history and nature of science.

The qualitative results of this study indicate that the improvement of students' understanding about the nature of science resulted primarily from the training with historical-rich teaching materials. This finding is different from the studies conducted by Herron(1977) and Lederman and O'Malley(1990). These researchers interviewed those high school students who changed views on the nature of science and found that the students were not able to indicate the reasons that caused the change. They concluded that the students' change in the understanding of the nature of science was implicit rather than explicit. However, the pre-service teachers in this study not only clearly indicated that their changes were caused by the reading of cases in history of science, but they all used historical cases to support their beliefs in the post-treatment interviews. It is suspected that there are at least two reasons behind the difference: first, college students, especially pre-service teachers, are more expressive and reflective than high school students; second, the assignment of integrating history of science into teaching materials has made a direct and significant impact on the pre-service teachers. In fact, this potential effect has been asserted by many leaders in this field (Conant, 1957; De Berg, 1989; Duschl, 1985; Matthews, 1994).

Implications in Science Education

The fruitful results of this study may serve as a pitfall for science educators who are interested in implementing history of science in their teaching. The student-centered historical instructional method of teaching (De Berg, 1989) is especially recommended. In which, activities of small group discussions, role playing, and simulating previous scientists' experiments are provided for students to be involved in a way of cooperative learning.

This study chose prospective chemistry teachers as subjects to be taught the history of science is significant for the development of science education. Once science teachers are introduced and equipped with such historical-rich materials, there are higher possibilities that they will include the history of science in their future teaching, simply because they explored this field.

At the end of the semester, while the students were sharing the materials in class, most of them asked for copies from others. The classroom climate provided evidence that the prospective chemistry teachers enjoyed doing the assignment of developing historical-rich materials. The results of this action research reveal that the implementation of history of science can make a difference in teacher training. Future studies can investigate other potential effects pointed out by Matthews (1994) or conduct investigations of this study with different formats for in-service science teachers.

References

Aikenhead, G. & Ryan, A. G. (1991). Students' views on the epistemology of science. Ottawa: Social Science and Humanities Research Council of Canada.

Aikenhead, G. & Ryan, A. G. (1992). The development of a new instrument "Views on Science-Technology-Society" (VOSTS). Science Education, 76(5), 477-491.

American Association for the Advancement of Science (1989). Science for All Americans. Washington DC: Author.

Behnke, F. L. (1961). Reactions of scientists and science teachers to statements bearing on certain aspects of science and science teaching. School Science and Mathematics, 61, 193-207.

Billeh, V., & Hasan, O. (1975). Factors affecting teachers' gain in understanding the nature of science. Journal of Research in Science Teaching, 12(3), 209-219.

Brickhouse, N. (1990). Teachers' beliefs about the nature of science and their relation to classroom practice. Journal of Teacher Education, 41(3), 53-62.

Brush, S. (1974). Should the history of science be rated X? Science, 183, 1164-1172.

Carey, R. L., & Stauss, N. G. (1968). An analysis of the understanding of the nature of science by prospective secondary science teachers. Science Education, 58(4), 358-363.

Carey, R. L., & Stauss, N. G. (1970). An analysis of experienced science teachers' understanding of the nature of science. School Science and Mathematics, 70, 366-376.

Conant, J. B. (1957). Harvard case histories in experimental science. Harvard University Press: Cambridge, Massachusetts.

De Berg, K. C. (1989). The emergence of quantification in the pressure-volume relationship for gases: A textbook analysis. Science Education, 73(2), 115-134.

Duschl, R (1985). Science education and philosophy of science: Twenty five years of mutually exclusive development. School Science and Mathemetics, 87(7), 541-555.

Gallagher, J. J. (1991). Prospective and practicing secondary school science teachers' knowledge and beliefs about the philosophy of science. Science Education, 75(1), 121-134.

Herron, J. D. (1977). Implicit curriculum- Where values are really taught. The Science Teacher, 44(3), 30-31.

Lavach, J. F. (1969). Organization and Evaluation of an inservice program in the history of science. Journal of Research in Science Teaching, 6(2), 166-170.

Lederman, N. G., & O'Malley, M. (1990). Students' perceptions of tentativeness in science: Development, use, and sources of change. Science Education, 74(2), 225-239.

Lederman, N. G., & Zeidler, D. L. (1987). Science teachers' conceptions of the nature of science: Do they really influence teacher behavior? Science Education, 71(5), 721-734.

Lin, H. (In Press). The effectiveness of teaching chemistry through history of science. Journal of Chemical Education, Accepted for publication in March, 1998.

Mackay, L. D. (1971). Development of understanding about the nature of science. Journal of Research in Science Teaching, 8(1), 57-66.

Matthews, M. R. (1994). Science teaching: The role of history and philosophy of science. Routledge: New York.

Miller, P. E. (1963). A comparison of the abilities of secondary teachers and students of biology to understand science. Iowa Academy of Science, 70, 510-513.

Ryan, A. G. & Aikenhead, G. (1992). Students' preconceptions about the epistemology of science. Science Education, 76(6), 559-580.

Soloman, J., Duveen, J., Scot, L., & McCarthy, S. (1992). Teaching about the nature of science through history: Action research in the classroom. Journal of Research in Science Teaching, 29(4), 409-421.

Table 1 Percentages of Students Who Changed their views

question #	control group (N=30)	experimental group (N=33)
1	10.00	18.18
2	13.33	15.15
3	10.00	24.24
4	20.00	30.30
5	6.67	9.09
6	20.00	21.21
7	6.67	6.06
8	20.00	42.42
9	16.67	24.24
10	16.67	18.18
11	13.33	15.15

Table 2 Pre and Posttest Means and Standard Deviations of the Students

group	pretest	unadjusted posttest	adjusted posttest
control	4.67	4.57	4.54
	(2.10)[a]	(1.89)	(0.32)
experimental	4.51	5.67	5.69
	(1.80)	(1.76)	(0.31)

a: numbers in ( ) are standard deviations.

Table 3 Source of Variance of the ANCOVA Result

Source of Variance	DF	SS	MS	F
Treatment	1	20.48	20.48	6.66*
pretest	1	18.33	18.33	5.96*
error	60	184.37	3.07	

*: $p < 0.05$

S8061324

ERIC®

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Promoting Pre-service Science Teachers' Understanding about the nature of science Through History

Author(s): Huann-shyang Lin

Corporate Source:

Publication Date: April, 1998

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents	The sample sticker shown below will be affixed to all Level 2A documents	The sample sticker shown below will be affixed to all Level 2B documents
PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 1	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2A	PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY Sample TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) 2B
Level 1	Level 2A	Level 2B
[X]	[ ]	[ ]
Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.	Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only	Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here, → please

Signature: Lin Huann-shyang

Printed Name/Position/Title: Huann-shyang Lin

Organization/Address: Dept. of chemistry, National Kaohsiung Normal University, 116 Hoping 1st Road, Kaohsiung Taiwan

Telephone:

FAX: (07) 711-4633

E-Mail Address: T1666@nknucc.nknu.EDU.TW

Date: April 21, 1998

(over)

Share Your Ideas With Colleagues Around the World

Submit your conference papers or other documents to the world's largest education-related database, and let ERIC work for you.

The Educational Resources Information Center (ERIC) is an international resource funded by the U.S. Department of Education. The ERIC database contains over 850,000 records of conference papers, journal articles, books, reports, and non-print materials of interest to educators at all levels. Your manuscripts can be among those indexed and described in the database.

Why submit materials to ERIC?

- **Visibility.** Items included in the ERIC database are announced to educators around the world through over 2,000 organizations receiving the abstract journal, *Resources in Education* (*RIE*); through access to ERIC on CD-ROM at most academic libraries and many local libraries; and through online searches of the database via the Internet or through commercial vendors.

- **Dissemination.** If a reproduction release is provided to the ERIC system, documents included in the database are reproduced on microfiche and distributed to over 900 information centers worldwide. This allows users to preview materials on microfiche readers before purchasing paper copies or originals.

- **Retrievability.** This is probably the most important service ERIC can provide to authors in education. The bibliographic descriptions developed by the ERIC system are retrievable by electronic searching of the database. Thousands of users worldwide regularly search the ERIC database to find materials specifically suitable to a particular research agenda, topic, grade level, curriculum, or educational setting. Users who find materials by searching the ERIC database have particular needs and will likely consider obtaining and using items described in the output obtained from a structured search of the database.

- **Always "In Print."** ERIC maintains a master microfiche from which copies can be made on an "on-demand" basis. This means that documents archived by the ERIC system are constantly available and never go "out of print." Persons requesting material from the original source can always be referred to ERIC, relieving the original producer of an ongoing distribution burden when the stocks of printed copies are exhausted.

So, how do I submit materials?

- Complete and submit the *Reproduction Release* form printed on the reverse side of this page. You have two options when completing this form: If you wish to allow ERIC to make microfiche and paper copies of print materials, check the box on the left side of the page and provide the signature and contact information requested. If you want ERIC to provide only microfiche or digitized copies of print materials, check the box on the right side of the page and provide the requested signature and contact information. If you are submitting non-print items or wish ERIC to only describe and announce your materials, without providing reproductions of any type, please contact ERIC/CSMEE as indicated below and request the complete reproduction release form.

- Submit the completed release form along with two copies of the conference paper or other document being submitted. There must be a separate release form for each item submitted. Mail all materials to the attention of Niqui Beckrum at the address indicated.

For further information, contact...

Niqui Beckrum
Database Coordinator
ERIC/CSMEE
1929 Kenny Road
Columbus, OH 43210-1080

1-800-276-0462
(614) 292-6717
(614) 292-0263 (Fax)
ericse@osu.edu (e-mail)